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EVOLUTION WITH PREVISION

ADDRESS BY

ROBERT BELL

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EVOLUTION WITH PREVISION.*

By Robert Bell, I.S.O., M.D., D.Sc., LL.D., F.R.S.**

Mr. President, and Members of the Board of Trustees, The Graduates, Ladies and Gentlemen:

When I had the honor of receiving your invitation a few days ago, through your Director, to address the graduating classes of the Clarkson Memorial School of Technology, I realized that there was not time to prepare a suitable discourse. Indeed, I had plenty of work at home to occupy every moment until I came here. I trust, therefore, you will not expect too much on this occasion.

I propose to speak, in the first place, for a few minutes from my own experience as to the advantages derived from a life devoted to the observation of nature and her laws, and in regard to the effect of such a life on one's own habits and thoughts; then as to the educational and economic value of scientific knowledge and its aesthetic influence, its tendency to raise men's thoughts from the grovelling things of earth to higher perceptions and nobler ideals. From my own observations on scientific subjects and among scientific men, I may also be permitted to offer the graduates of today some words of advice in regard to matters connected with their future work.

A life given up to nature-study cultivates accuracy of observation and truthfulness of description, and helps us to be more logical and concise in our conclusions. A great deal of time is lost in many walks in life from the difficulty which uneducated men, especially those not educated in the natural sciences, experience in trying to describe what they wish to picture to others.

Then another point which I may touch upon is, what the study of nature may teach us with reference to a Creator, how creation has been carried on, and what may in the future be in store for us and for the world,—subjects which concern us all very greatly and on which this kind of study may throw much light. The problem of a future state for man is one which none of us can afford to neglect, and it is one which really occupies more of the thoughts of all men than they may care to acknowledge.

Scientific studies also establish a legitimate philosophical skepticism, so that one may not be easily deceived by questions and subjects which really have no basis of truth in them. Before taking the time or trouble to investigate a subject or answer a question, we should first ascertain whether there is any truth in it..

Where you are at liberty to choose your own subjects for investigation, select useful and promising topics with great possibilities in them, and especially such as those in which you may have good opportunities or facilities for prosecuting the work. A new problem presented for solution, or an incipient invention which you have thought of may prove interesting, yet after you have mastered it, you may realize that it was not worth the labor and study you devoted to it, and that you might have been more profitably occupied at something else.

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* Baccalaureate Address, delivered 9th June, 1907, at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y.

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The chances of success in your profession will be much enhanced by cultivating care, system or method, accuracy, thoroughness, punctuality, cheerfulness, patience and good nature. In regard to carelessness in connection with the engineering professions, there is much unnecessary loss of life and property, much pain and suffering, due to what are popularly called "accidents", almost all of which could have been avoided by care and forethought. When we reflect, after almost any one of the terrible railway or other "accidents" has taken place, we can see how easily it might have been prevented by the exercise of a little caution and common sense. It is the duty of the engineer, whether civil or electrical, mining or mechanical, to try to prevent these unnecessary calamities.

Another important point in the investigation of nature is that such studies serve to wean us away from the idea, which is all too prevalent in these days, that the pursuit of gold is the one great object in life. We all know that, even if we accumulate a great deal of gold, we cannot take it with us at the end of this life, whereas knowledge acquired here may be of service in a future state of existence. Gold in the sight of the Almighty is not different from the commoner things of earth.

A piece of good advice to beginners in any profession is to do well whatever may be entrusted to them. In this way confidence is established, more business will come to them, and success will be sure to follow. A young engineer may be very clever and capable, but unless he is determined to take care that he does good work, he will not deserve to succeed. It will be better for him not to undertake a piece of work at all than to do it indifferently. System and accuracy are great factors in the pursuit of any of the scientific professions. No kind of slovenliness, no errors in figures, no inaccuracies of any kind should be permitted. The habit of accuracy will grow if cultivated. Thoroughness in detail is also a great virtue. Popularity will help you appreciably, and punctuality, "the politeness of kings", is as essential in the engineering as in the other professions.

Men and women alike should cultivate a happy disposition, both for their own sake and for the sake of others. We can all live notwithstanding our misfortunes. Scarcely anything happens to us that might not have been worse, so that we should always be thankful instead of complaining. I once had a friend in Toronto in rather humble circumstances whose little property was all destroyed by fire. When I met him soon afterwards, I found him as cheerful as ever. He said, "Why shouldn't I be happy? I couldn't help this thing; and as long as the sun shines and God rules in heaven and John A. Macdonald in Upper Canada, I'm going to be happy."

I heard a story of an old lady in England who worried all her life and made herself miserable indeed. When she came to die, looking back upon her life she said: "After all I have really had a happy life, although I did not know it. Nearly all my troubles never happened."

The numerous important applications of scientific knowledge to the convenience of man and the saving of labor in our own time, to say nothing of the fresh discoveries which have been made but not yet applied to practical purposes, lend great interest to the study of applied science at the present day. There has probably never before been a period when scientific discovery and the application of knowledge to the purposes of life went on so rapidly as now. The time is at hand when scientific knowledge is going to subdue the earth, when man shall come to a conscious realization of his power over nature, and achieve that dominion promised him.

Technical training is recognized as the great educational want among civilized nations, and much more attention is being paid to it now than it has received at any previous time. The object is no doubt in many instances to develop industries, to create future trade and commerce, and to provide for the well-being of their own people at home as well as of those who go out to the extensive territories or dependencies of the nation in all parts of the world. Part of this modern idea is to furnish competent overseers and managers to utilize the labor of natives in the development of the natural resources of their own lands, so that civilized man may turn to good account and hold control of the large and varied regions of the earth that have fallen to his share.

A few nations form such a vast domain in themselves that they possess ample scope for thus increasing trade and business within their own boundaries and have plenty of room for the employment of almost all their trained technical men at home. The fact that the value of technical education is daily becoming more and more prized in every civilized country, as being of the greatest benefit for the welfare of the human race, speaks volumes for the foresight and wisdom, the philanthropy and patriotism of the ladies who established this Memorial School of Technology in honor of their brother, Thomas Streatfeild Clarkson, and who founded here, over eleven years ago, the Institution in which we are met today.

Scientific education is a great factor, not only in civilizing, but in humanizing men. It makes them tolerant of each other's customs and beliefs, and it has in this way already contributed largely to the growth of freedom and the progress of the world. How ridiculous it is to the mind of a scientific man engaged in working out the truths of nature to suppose that anyone has a right to coerce others into adopting particular notions on such matters as may perchance be floating about in his own head, and especially such ideas as may not be founded on any sound basis. The enlightened public now knows that the advocates of such unreasonable intellectual tyranny in former years were themselves often densely ignorant men, not only in matters upon which they essayed to control the mind of man, but in other things as well.

Some men who think they know everything, affect to sneer at the supposed insignificance of "this miserable little planet of ours", so small compared with some others. Don't let us be too sure that it is insignificant, because it is of smaller size than some of the other planets, for we shall see that after all mere size does not count in the case. The large planets are probably still in a heated state and quite uninhabitable. The earth seems to be the only good planet in the solar system and perhaps even beyond this whole system, for, although there are many larger suns than ours, there is no certainty that they have planets revolving round them. It need not be considered as at all wonderful if our sun differs from others in this respect.

Again, the other planets of our own system may be only make-weights, as it were, serving some good purpose, as yet unknown in the economy of our planet. All this may look like a great expenditure of material and energy for so small an object as the earth. But mere quantity or numbers do not seem to be of any account with the Creator, any more than does time, space, or distance. Economy in anything, as one commonly defines economy, does not appear to have any place in the work of His hands. Take as a single example the prodigious heat of the sun, which has apparently been going to waste for an eternity of time. The quantity which falls upon all the planets of our system combined is an insignificant fraction of the whole. The planets while in a glowing state, as probably some of them still are, require no additional heat at any rate.

We are so hampered by the very restricted and primitive ideas of our ancestors in regard to everything in nature that we seem to grudge the prodigality of the Creator in all things, and to set limits to the natural forces on account of our own weakness; but God uses a different set of weights and measures from those with which we are familiar, and which our yet undeveloped minds cannot comprehend.

A story which I heard the late Sir Charles Lyell relate at the meeting of the British Association for the Advancement of Science, at Bath, in 1864, will illustrate what I have been trying to describe: An Irishman, who had become suddenly rich, was asked to subscribe to a good object. He put down his name for a small amount. The collector suggested, "We had hoped to get more than that from you"; whereupon he changed the figure to a good round sum, at the same time remarking, "I find it hard to get the chill of poverty out of my bones."

On one of my explorations, in talking to an intelligent Indian, I referred to the large size of the lakes and rivers of the country we were in. He replied: "There is nothing wonderful about that. Why should they not be large? The Great Manitou could make them large as easily as small, but he wished his people to have wide hunting grounds and big rivers and lakes to fish in." On a previous occasion the same Indian had told a missionary that the mind of the white man was mean. We shall have gradually to change our opinions, therefore, with each larger view of nature and of man's interpretation of his relations to the world.

The abundance with which nature is supplied extends also to the organic world, as illustrated, for example, in the enormous numbers of the seeds and spores of plants and of the ova of most species of animals. The disease germs and the spores of ferns, fungi, etc., are almost innumerable, while among many of the higher plants including trees, a birch or a poplar, for instance, ripen annually seeds enough to be wafted in a single day over a whole province. Among animals, the common sea urchin furnishes 16,000,000 ova every year, while some vertebrates, such as the codfish, produce hundreds of thousands of eggs at a time.

We find all the processes of nature and all the properties of matter so exquisitely balanced, that they support each other so exactly, and are so interdependent on each other, and that moreover this condition of things has existed for so long a time, that we are forced to the conclusion that this is the result of nothing less than the highest intelligence, and that the earth, and indeed the universe, could not exist otherwise than as they are.

It seems the more evident, therefore, the more we look into the question, that everything civilized man should require had been intentionally stored up or prepared for his use, and that the natural forces are just such as suit his requirements. Magnetism and electricity, the phenomena of light, heat, and radiant energy, gravitation, the expansive power of steam, and the explosive power of chemical dissociation; also such materials as coal, petroleum, natural gas, and the various useful metals, some of them in great abundance, and which have only been discovered in recent times, and a thousand other things, have all existed for ages, although it is only now that we know enough to find them out and turn them to account. As soon as anything becomes necessary to supply a want in the progress of our race, it is forthcoming. Each generation seems to think that it has reached the limit of discovery, and yet every new invention appears to be the most wonderful of all. Who can say how long this is to go on, and what is to be the final outcome of it all, the final destination of man?

It may appear conceited on our part to suppose that from the beginning the earth was intended to be the abode of human beings, and that it was constantly being prepared and finally brought to its present habitable condition with that end in view, but today this seems probable; and unless ours is to be followed by some higher type of life, which does not appear likely, we have now reached the stage when man, "the paragon of animals", is in almost full possession of the earth, and is rapidly subduing the world of nature to his material and other beneficent purposes and developing withal his own intelligence. This planet, therefore, appears to be serving God's chief purpose in the scheme of creation. "All that's great in earth is man; all that's great in man is mind". Everything seems to point in this direction. In other words, the developed and highly organized condition to which the world has been brought for the advent of man and the purposes to which he is already turning his environment by his growing intelligence seem to indicate that the earth was made for man and man for the earth.

In illustration of this idea, we may consider the use he is now making of one of the numerous resources under his control. The vast scale on which metallic iron is made from its ore and so readily converted into steel, and this again into a large variety of forms for the construction of gigantic ships, and engines and turbines of thousands of horse power, into rails and bridges for our highways, and steam and electric locomotives for hauling the heavy trains, as well as a myriad of architectural applications of steel, show a connection between the existence of this ore and the knowledge and skill necessary for converting it into steel and of then shaping the material for the important purposes just mentioned. The ore was evidently not intended to lie forever unutilized. If this ore were not formed for man, he shall at any rate have used up the best of it in a comparatively short period, and will then undoubtedly consider that he came by it honestly.

The power to use the facilities which the earth affords for rapid transportation and for instant communication of all its parts with each other, no matter how distant, the power of making the voice heard for hundreds of miles, of transmitting energy and intelligence under and over the sea, across the continents and through the air, are only a few more of the reasons which might be added among those already known to us for entertaining the high ideas of our race and of the position in the world held by man; and which, nevertheless, at the same time make us humble ourselves in the sight of the infinite and the unknown that is yet beyond our grasp and comprehension.

The study of nature in general, or of any branch of science in particular, is far from leading to so-called religious skepticism; on the contrary, it naturally conduces to a belief in God and His goodness to man. A belief in the existence of a deity, of God, in something infinite, omniscient, unseen, a power beyond ourselves that causes everything to exist and that cares for man and all created things, is a belief inherent in human nature. Man cannot get away from this idea. It was necessarily crude in primitive man. He naturally pictured an anthropomorphic god, of giant size, and with attributes like his own. But even now, the average educated man appears far from realizing how inconceivable is the greatness and goodness of God as shown in His works and His omnipresent power, throughout the universe. creating all matter, endowing and sustaining all life, and manifesting Himself in what we call natural laws and the phenomena of the forces of nature combined with perfect intelligence. One of these natural forces, the latest to be manifested on the earth, is vitality, as we call it, or life in organic forms and beings. These have been developed into almost innumerable systematized forms by processes which we have come to recognize as evolution, not by blind chance, therefore, but by the intelligence which guided the process.

I think that every reasonable man will admit what appears to be self-evident, namely, that to the Creator neither time nor space, nor distance, nor size, quantity or quality of matter, nor height, nor depth, nor darkness, nor light, nor heat, nor cold, nor any other condition of the physical universe, has any significance whatever as to comparative amount or relations we men usually assign them. In regard to time, for instance, it has gone on eternally in the past and will go on forever. Geologists and physicists formerly estimated the age of the earth, since it had condensed from a gaseous state into a molten ball, to be from one hundred and fifty to two hundred millions of years; but recently it has been found, from investigations on the newly discovered element radium and some of its allies, that there appears to be a new way of measuring the length of time that has actually elapsed. The investigation of the structure of a certain radium-bearing mineral found in Ceylon may show that three hundred millions of years have passed by since that mineral began to be formed, and that period may have occurred when the earth itself was well advanced in age.

From analysis of the spectra, we find that the chemical elements which enter into the composition of the earth exist also in the heavenly bodies, and such is probably the constitution of all the matter of the universe, which would thus appear to be a mere repetition of a small number of elements which may all have been derived from one.

The endless repetition of the same elements in the composition of the larger, as well as of the smaller heavenly bodies, reminds us of the repetition, and it might appear to a similar extent, in the waves of light, heat and electricity, in the ether medium throughout space; of sound, in air; and of the molecules of water, in the waves of the sea, surrounding the earth. Therefore, the manifestation of the power of the Creator does not seem to be greater in the development and evolution of a large body than in a small one, and thus the comparative size alone of our planet does not enter into the consideration of the actual importance of the human race.

All the physical conditions now existing at the surface of the earth, from the structure or arrangement of the massive and the stratified rocks, the pressure of the air, the phenomena of the weather, the flow of rivers, tidal changes, etc., to the muscular strength and other adaptations of the animals to a habitable world, have apparently adjusted themselves from the beginning, or have been gradually developed to suit exactly the gravitational and other cosmic forces peculiar to the earth alone. The conditions, therefore, which have now been reached would not harmonize with a planet of a different size or mass. Thus it appears that it would not be possible to have a terrestrial condition of things different from that which exists, where everything is so well established and works together so admirably for some ultimate good in the plan of the universe whose builder and maker is God.

The state of the earth, considered furthermore as a whole, and the laws which regulate all its movements, bring about the physical conditions necessary for our enjoyment of life.. The eccentricity of the earth's orbit in its revolution around the sun,, its rotation on its axis, and the inclination of that axis to the great plane of the ecliptic, produce day and night, summer and winter, with the ever changing yet recurring terrestrial phenomena, conditions, in fact, which are immediately conducive to the welfare of our own species, as well as of everything else upon which human beings depend. Some men imagine that the earth has many imperfections and that if they had had the making of it themselves they would have introduced several improvements. But we have seen that the present state of affairs is the outcome of development, an evolution under immutable natural laws, administered with unerring wisdom, a supreme intelligence and prevision, so that nothing of importance could have been made otherwise than as it exists without upsetting the divine harmony of the whole.

The control or governance, or power of God over the universe appears to be expressed, in part at least, through the physical phenomena produced by natural forces, such as gravity, light, heat, electricity, magnetism, etc., and which seem to us to be capable of being present everywhere. The action of these forces is certainly accompanied by intelligence, otherwise the beautiful order which we see in all things throughout the material world could not be maintained. A more suitable expression of the divine power is perhaps manifested in the vitality of plants and animals, especially in the intelligence of the latter, and the more so as we ascend in the scale to the reasoning powers of man.

As I have just said, nothing could be more perfect and well established than the present condition of the earth, and nothing could be more wonderful and accurate than its movements in space. In comparison with many of the heavenly bodies, it is true that it is very small; but this fact only makes the accuracy of its motion the more wonderful. If we represent the earth by a small pellet of shot, the moon by a grain of sand, and the sun by a large orange, we have the means of forming an idea of what our planet and its satellite accomplish in one revolution around the sun. Imagine then that these two bodies as a single system rush along in the orbit at planetary velocity, the moon continuously revolving around the earth and drawing it out of its orbit a distance of about ten thousand miles, and that the earth itself travels with a varying velocity around the sun, at one time faster and at another slower than the normal, but always covering equal areas in equal times,—it would appear to be difficult for the earth to keep up to this time-table, owing to these different and ever-varying rates of speed. The earth, represented by the pellet of shot I have spoken of, would travel around the sun (represented by the orange) in the path of an ellipse about ten miles in its least diameter, or cover a distance of more than thirty miles to represent each revolution around the sun; and yet at the end of the year in which, let us suppose, it completes its journey, it would arrive at a certain given point exactly at the right moment of time, never varying a second. I think it is a most wonderful thing that a mass of matter should travel so far at continuously varying speed and yet, year after year, century after century, for untold ages of time, it should come to the line punctually on the dot, so to speak.

What could be more wonderful and beautiful, therefore, than this highly finished planet, whether it be viewed as it must certainly appear from a distance, as a splendid orb, accompanied by its huge moon, ever shining with a silvery light reflected from the sun, and passing through its constantly changing phases, or again as it is seen near at hand by its own inhabitants. If it could be seen from a distant point, sufficiently removed to enable the human eye to take in its whole outline, its disc would appear to be beautifully diversified by large colored areas of light and shade, due to the contrasting seas and continents and to the clouded regions, alternating with others of sunshine. It must indeed appear as a perfect gem in the sky, contrasting significantly with all other objects around.

To its own inhabitants at closer view the earth is equally lovely, with its landscapes of dark and light green forests, shining lakes and sunlit prairies, its silvery rivers, its waterfalls, hills, dales and mountain tops; the sea, with luxuriant vegetation on the shores and islands of the tropics, or dotted with drifting fields or towering bergs of pure white-surfaced ice in the north. Our nature craves variety. We have it always with us in the seasons as they change; in the beautiful pure white snows of winter; in the refreshing rains and the gentle breezes of spring, contrasting strongly with the thunderstorm of summer, its vivid lightning and awe-inspiring noise, and the driving gales of autumn; or again we have variety in the restful calm and the sparkling sea, in the bright sunshine of a summer morning, or in the blue ethereal sky and soft billowy clouds of midday. Later in the year, at the season when we have the rich tints of the ripened grains and fruits, and variegated foliage of the trees, we may also feast our eyes on the sunsets of autumn, with the wide-spread, o'er-arching and gorgeous cloud effects whose colors so exquisitely blend with the landscape against the western sky. To crown all and embellish all, we have the endless variety of flora, all the graceful plants with their beautiful flowers which supply the finishing touches to God's handiwork on the earth; while the fauna, the living creatures, with myriad forms and movements, give it life and animation. To the contented mind, at peace with God and in love with all the world, no better place need be desired for the present habitation of the soul of man than the earthly paradise in which we dwell.

And so I will close, wishing you all God-speed in the journey of life, upon which, it seems to me, none could have entered more auspiciously and more hopefully than the youth whom I have had the joy and pleasure of addressing. My heart's desire for you all and prayer to God is that in continuing to be workers together with Him and for Him, in this His beautiful world, each may find that peace which passeth understanding, and attain that love which passeth knowledge.